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AUTHOR Miller, Christopher W.; Kennedy, William R.
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ABSTRACT

The purpose of this study was to determine characteristic learning patterns of technical education alumni at a mid-western engineering school (institute of technology). The research also included efforts to track cognitive and career development of the engineers in the study. The research sample consisted of five graduating classes selected at five year intervals from 1955-1975 and matched with a comparative sample from a nearby School of Applied Social Science. The primary measurement instrument used was the Learning Style Inventory (LSI) developed by Kolb in 1976 plus repeated presentations of a characteristic skills list matched with the LSI to measure career and education development. The group was sampled via a questionnaire. The primary unit of analysis involved was a two way ANOVA. Results suggested a disparity between the immediate interests of the students and long term career needs. Work study programs and a broader based education for the technical professional were recommended. It was determined that there is a general need on the part of both the educating institution and the student to more completely understand the limitations of a technical education within the context of a technical career. (Learning style and process models and graphs of study data are appended.) (LRA)

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The Effects of Work Experience and Undergraduate Education On The Learning Style and Career Development of Technical Professionals

by

Christopher W. Miller
White Consolidated Industries

William R. Kennedy
Cuyahoga Community College

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of the
Northeastern Educational Research Association

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ABSTRACT

The purpose of this study was to determine characteristic learning patterns within the alumni possessing a technical education background. This research included efforts to track the cognitive and career development of the engineers. The primary instrument used was the Learning Style Inventory (Kolb, 1976) and repeated presentations of a selection list matched with the LSI to measure career and education development. Five graduating classes were selected at five year intervals from among the alumni of a mid-western engineering school. The group was sampled via a questionnaire. The primary analysis involved was a two between subjects, one within subject ANOVA. Results suggested a disparity between the immediate interests of the student and his longer term career needs. Work study programs and a broader based education for the technical professional were recommended. It was determined that there is a general need on the part of both the educating institution and the student to more completely understand the limitations of a technical education within the context of the technical career.

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THE EFFECTS OF WORK EXPERIENCE AND UNDERGRADUATE EDUATION ON THE LEARNING STYLE AND CAREER DEVELOPMENT OF TECHNICAL PROFESSIONALS

In the past the mission of higher education has appeared to be one of academic focus rather than of the development of the whole person (Jackson, 1975). Opposing this view has been the stated commitment on the part of many institutions specializing in science and technical education to develop the student into a well rounded individual with solid leadership potential (Miller, 1979). Providing a broadening experience, as well as honing an individuals technical skill, has long been a challenge for schools training the engineer. The suggestion of sacrificing high levels of technical competence for a more liberal learning experience has been debated by many factions in the educational community. First, by the students themselves with specialized interests and a desire for proficiency, second, by the students' potential employers and, third, by the technical faculty groups that have been seen by nature seeking the highest possible levels of competence. Regardless of the reason, the educational experiences at schools specializing in science and technology have been ones that retain depth in the sciences at the expense of breadth in human knowledge and personal development.

The purpose of this study was to determine characteristic learning patterns within the alumni of a mid-western institute of technology (IT). This research included efforts to track the technical professional in his cognitive and career development as well as through his learning exprience. It was presupposed that the educational and career activities of IT alumni would demonstrate a response of the individual to his educational base.

Dalton, Thompson, and Price (1977) and Kopelman (1974) in a series of studies on career development and obsolescence in engineers suggested a career development model comprised of four stages. Career growth for the engineer was perceived as one extending from an apprenticeship after formal education ultimately to one of sponsor and as a key figure in his organizational structure.

Experiential learning theory (Kolb, 1976) has also suggested a developmental model particularly useful in an analysis of the technical professional. The learning process is divided into two continua (figure 1). The first is bounded by concrete experience (CE) and abstract conceptualizatin (AC), and the second by active experimentation (AE) and reflective observation (RO). As the individual develops he passes through three stages; acquisition, specialization and ultimately integration (figure 2).

The Design

The design of this study required an attempt to define reciprocal relationships between the person, his environment and behavior. The reciprocity inherent in this relationship formed a triangular bond difficult to enter into a standard experimental format. To encompass the problem 20 variables were selected that at once act upon and react with one another. This variable group was viewed by the character of the whole as well as through the relationship of the parts and was therefore, truly organismic.

The group of 20 organismic variables encompass five major areas associated with lifelong learning:

1. Learning Style Inventory (subscores) .....cognitive growth.
2. Current Job Characteristics ..... perceived real environment.
3. IT Education Evaluation .....past education environment.
4. Work Experience Education Evaluation .....perceived real educational environment.
5. Work Abilities .....perceived behavorial potential within the work environment (that which has been learned).

Two distinct <u>independent</u> factors were included in the research enhancing the environmental corner of the triangle. These included:

6. Cohort Groups (year of graduation) ..... a past environmental given.
7. Job Category ..... a current environmental given.

The first five variable groups were divided into subsegments corresponding to the LSI subscore. This additional subdivision provided the basis for comparison and allowed the analysis to proceed via a multifactored repeated measures design (Winer, 1971, Chapter 7).

A survey technique of data collection was utilized and instituted via an extensive questionnaire. Incorporated into the questionnaire were a variety of data collection instruments and subjective data probe. The instrumentation pertinent to this study included the Learning Style Inventory, repeated presentations of the characteristic skills list and demographic information probes.

Primary subjects included Institute of Technology alumni graduating in five year intervals between 1955 and 1975. A comparative sample was drawn from the graduates of a nearby School of Applied Social Sciences (SASS) and matched with the IT graduates.

Results

The comparison of the plotted LSI scores of the sample groupings demonstrated that while differences existed between the group means, similarities were also prevalent. In observing the plotted subject scores it was concluded that the engineering alumni were primarily convergent. Many subjects also fell in the assimilator and accommodator quadrents with the fewest falling into the diverger quadrent. Comparing this result to those of a different alumni group (SASS) indicated a distinct difference between the two discipline groups. As is demonstrated in Figure 3 a great deal of overlap also occurred, with subjects from both disciplines falling in all learning style quadrents. When comparing the LSI scores of cohort groups and job descriptions only a negligible differences were noted ($F = .67$, df 24,597; $p \leq .880$). It was evident that a great deal of overlap occurred beween the plotted scores for those groups. From an analysis of this information it can be concluded that despite some group differences, differences within groups were of greater significance than the difference between groups.

Theory predicted that as the individual moved away from graduation, his undergraduate education would become less important and that his learning experiences at work would come to be perceived as being more important. It was felt that evidence supporting this type of learning pattern would provide additional support to Experiential Learning Theory. However, differences of opinion among subjects concerning their lifelong learning experience were not affected by distance from graduation (cohort group) ($F = 1.00$, df 12,573; $p \leq .450$). Differences could be measured only along the lines of job description ($F = 2.89$, df 6,573; $p \leq .009$).

The second finding of this phase of the study effected the preconception of a lifelong learning pattern. The expected inter-action between professional education and work experience did not materialize. The most notable difference was within the subscores across the learning situations considered. Learning activities associated with active experimentation and concrete experience were considered a comparatively unimportant part of professional education, but of equal importance to all other subscores within work experience.

The pattern in lifelong learning that had been anticipated was not found. However, it was concluded from the results that differences in the perception of lifelong learning for IT graduates were associated with career development as opposed to a more general pattern of adult development; "age" or "year of graduation." Further, it was discovered that skills associated with all styles of learning were perceived as being contributed to by work experience, by all subjects. Differences were registered, however, an overall pattern of strength was maintained. The evidence suggested that the

work experience represented a more integrated learning environment than that associated with professional education. While this was not the specific evidence sought, it was none-the-less evidence supporting the strength of the experiential learning process.

The comparison of job characteristics and work abilities was an effort to associate the individuals perceived environment (his job) with his perceived accumulated learning (his work ability). This research demonstrated that work abilities were perceived as more integrated than were job characteristics. Differences, as with the learning variables, were found over job description ($F = 2.49$, df 6,600; $p \leq .022$) rather than cohort group ($F = 1.48$, df 12,600; $p \leq .127$). A unique interaction was discovered for job characteristics and work ability across job description. The alumni in the management group, perceived their jobs as requiring the skills of concrete experience and active experimentation to a significantly greater degree. Further the management group required skills of reflective observation and abstract conceptualization to a significantly lessor extent than had their fellow alumni, the engineers.

The pattern found in job characteristics was echoed, though not as directly, in the work abilities measure (see figure 4). The management group perceived themselves to have been significantly more able in concrete experience (people oriented) and active experimentation abilities than was perceived to have been the case for engineers. For reflective observation there was parity across all job categories, and abstract conceptualization proved to be less important to managers than engineers.

The pattern established would have been predicted by the Thompson, Dalton, Price stage theory. As the individual progresses in his career from a level of technical competence to a level of interpersonal competence. Those competencies previously developed, and no longer applicable within the current job, may not be lost but may simply lethargize through disuse. Those competencies not yet required by the job (i.e. of the engineer) are not as developed as they will be when brought into practical use within the career. Regardless of their career level, the subjects in this study perceived their own work abilities as having been consistently more integrated than the abilities demanded by their current job. Skills involving abstract conceptualization and active experimentation were placed in areas where the individual perceived himself as significantly more able than required (within the capacity of his job).

Summary of Results

This study was designed along the format suggested by Bandura (1978) in his representation of reciprocal determinism. From the examination of the data a clarification of the Bandura model within this framework was possible (Figure 5). The individuals in this study were diversified in learning style. The differences within each subject group were more notable than the differences between groups. The individuals' job category was the only grouping factor of significance. The learning environment was divided into two areas, professional education and work experience. Furthermore, professional education was perceived as a primarily ABSTRACT and REFLECTIVE experience. The first job category "engineer" was perceived to have been more heavily reliant on those types of skills than was indicated by the

subsequent management positions. Work experience was perceived to have been a more integrated learning process. The skills needed in management took a new and increased level of importance as work experience became the primary learning factor. This process culminated in an integrated work ability.

The education provided at the Institute of Technology was perceived as preparation for the activities of the engineering profession's technical arm. Further expectations expressed by the institution were actualized as individuals continued to exhibit ongoing resilience through lifelong learning.

Implications

This research has indicated that the process of preparing students for a career in science and industry was carried out to the satisfaction of most IT alumni. Seventy-five percent of those canvassed indicated that they would return to the undergraduate institution to repeat the experience if they had to do it again. Yet distinct shortcomings have been observed to exist within the educational process when it was compared to the work environment. It is important for both institution and student to understand the limitations of the undergraduate preparatory process currently being promoted as "technical education." No skill was perceived as being learned better via the formal education process than through work experience. In the skill areas involving people oriented activities, alumni felt ability was derived almost exclusively from work experience and not from their undergraduate learning. Any claim that a technical education has prepared the student for both the work environment and the technical aspects of work would have to be questioned.

The problem has been addressed to by many professional disciplines through the institution of work study programs. A primary example is the field of medicine where increased emphasis has been placed upon patient/doctor interaction early in training; interactions that promote the awareness of the developing physician to illness as a holistic problem beyond biology. At many schools engineering education programs have become proponents of work-study curricular (Cooper Union, 1960). The extension of such programs have been supported by this research.

That a strong science and technology education was not perceived as being sufficient to meet the individuals' needs for concrete experiences (and to some extent in the active areas) is a definite criticism of the educational process. Results were consistent with Jackson (1975) and other educational theorists in suggesting that the academic community has oriented training toward the development of a specialist rather than for the "whole person." Dalton, Thompson, and Price (1977) have suggested that the introductory work experience of the trained engineer should be considered an opportunity for transition from school to industry. The authors would go further in suggesting that this transtion is in large part a socialization process that will address the remediation of the individuals underdeveloped skills in human interaction. These skills are perhaps less important to the engineering profession than to other careers, but are still paramount to the majority of engineers in industrial positions. That alumni have successfully demonstrated resilience to the variety of job demands encountered, with what they perceive as a satisfactory performance, is a credit to their fortitude. However, it calls into question the narrow nature of their educational base.

The disparity between the immediate interests of the student and his longer term needs suggest an opportunity for career education and planning. The demonstration, through this research, that abstract learning continues on the job at a level equivalent to the level assumed for undergraduate education suggests a basic fallacy in strict academic curricula. A break in the academic rigor for industrial experience does not necessarily indicate a break in scientific growth. Furthermore, there is little doubt that the work experience is more in line with a students career goals.

Beyond the suggestion of strengthened work-study programs, development of the students accomodative skills remains a responsibility of the institution that ostensibly prepared the engineer for industrial leadership. Programs embedded in a students humanities core or presented as a seminar series by the alumni office should be commended. Finally (understanding the limited importance of undergraduate training to alumni moving into managerial careers) the institution may wish to initiate a supportive effort for the ongoing educational activities of alumni. An active participation in the lifelong learning efforts of alumni might well be an appropriate activity for the educational institution that inaugurated the individual students career development and challenged him to a life of resilience through learning.

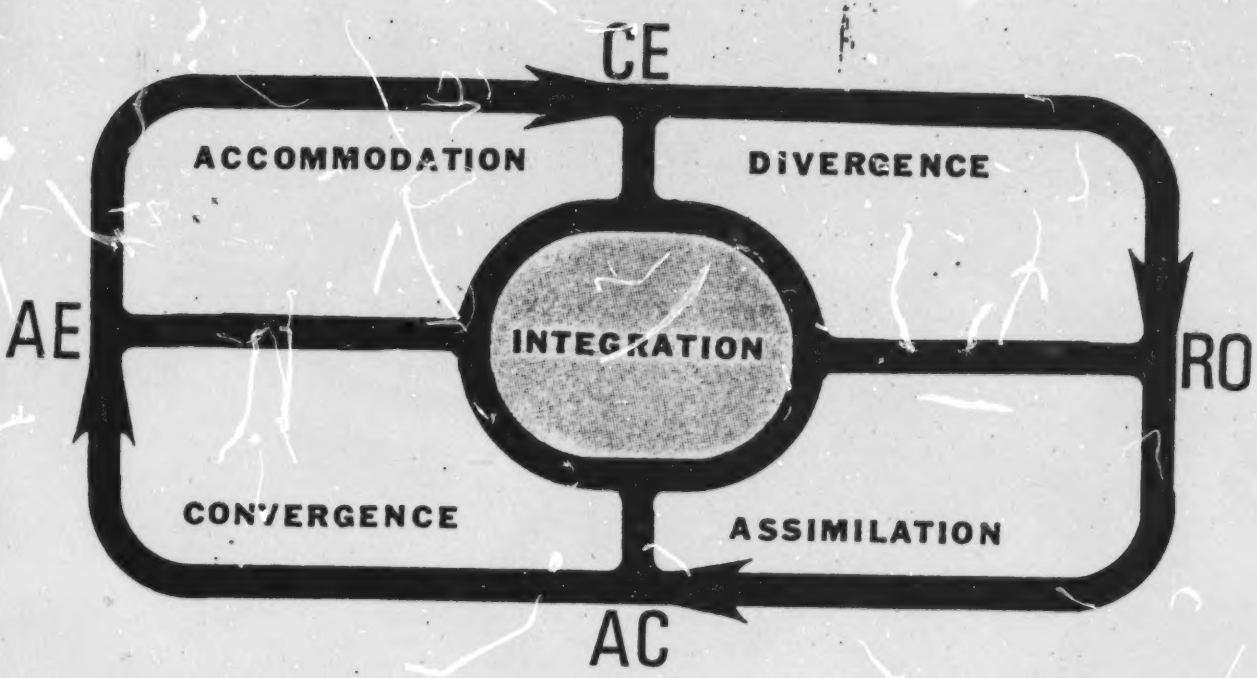

Figure 1. The positioning of the four learning styles embedded within the learning cycle.

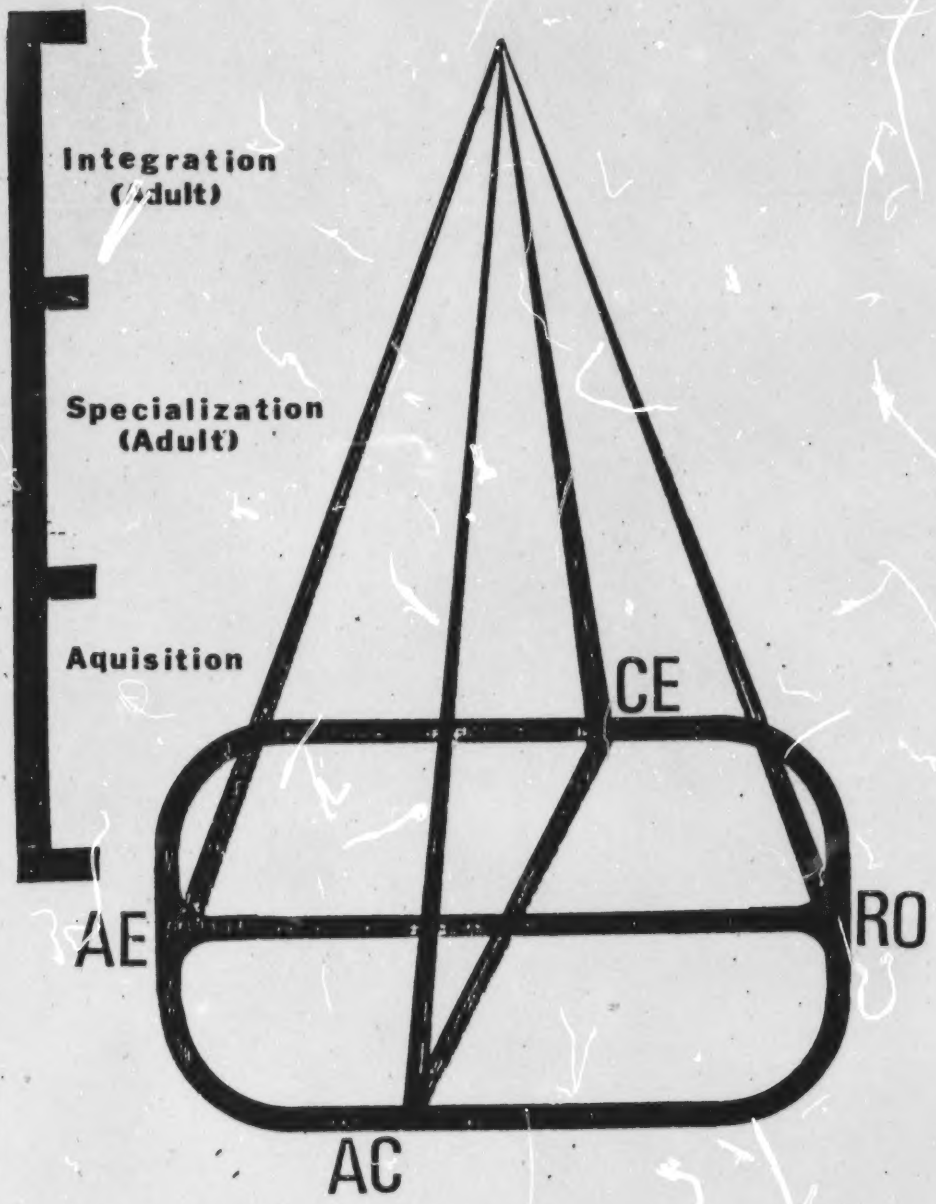

Figure 2. The experiential learning theory developmental model, "the cone", suggesting three stages of the learning process.

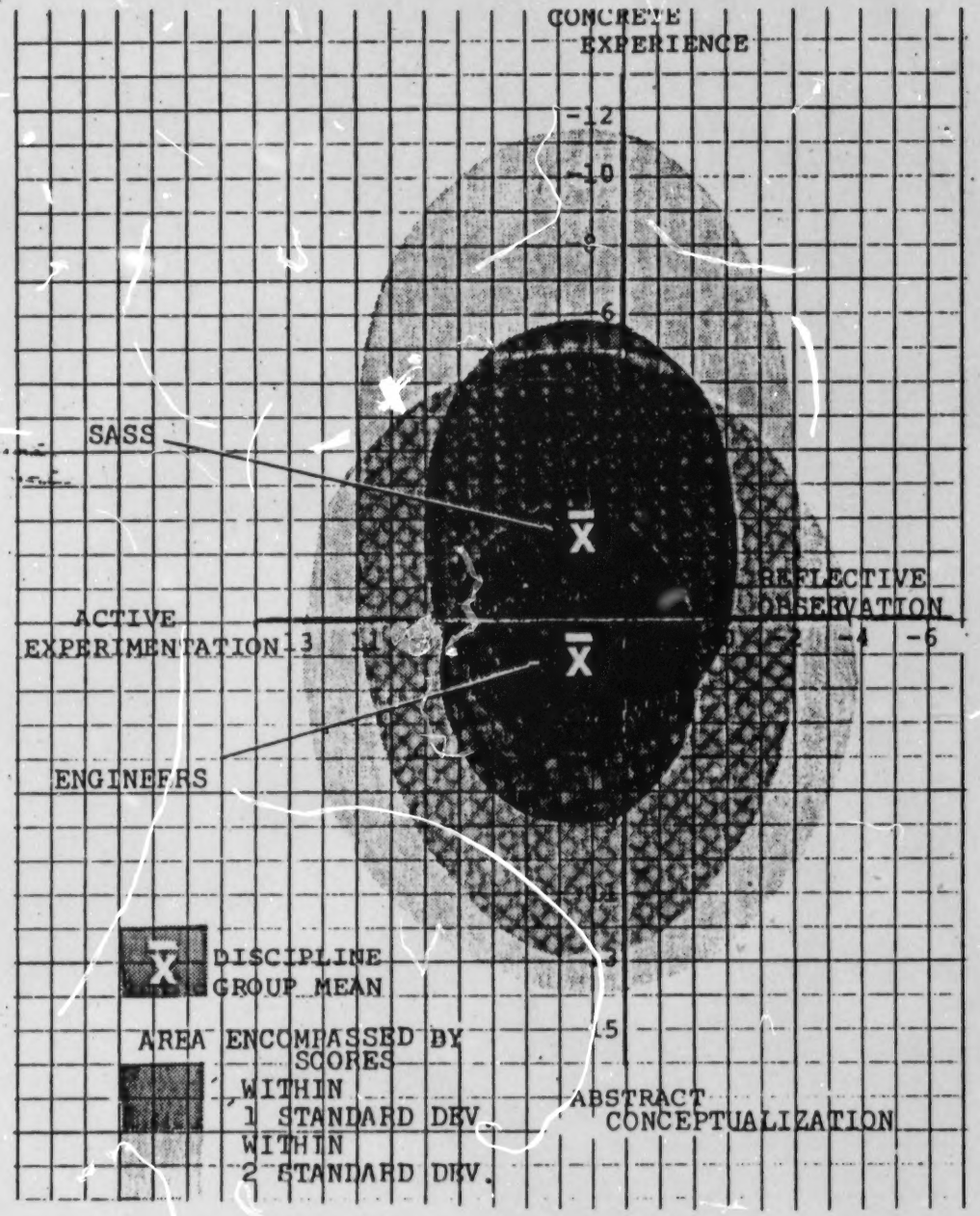

Figure 3. The distribution of learning style scores for engineering and social science graduates.

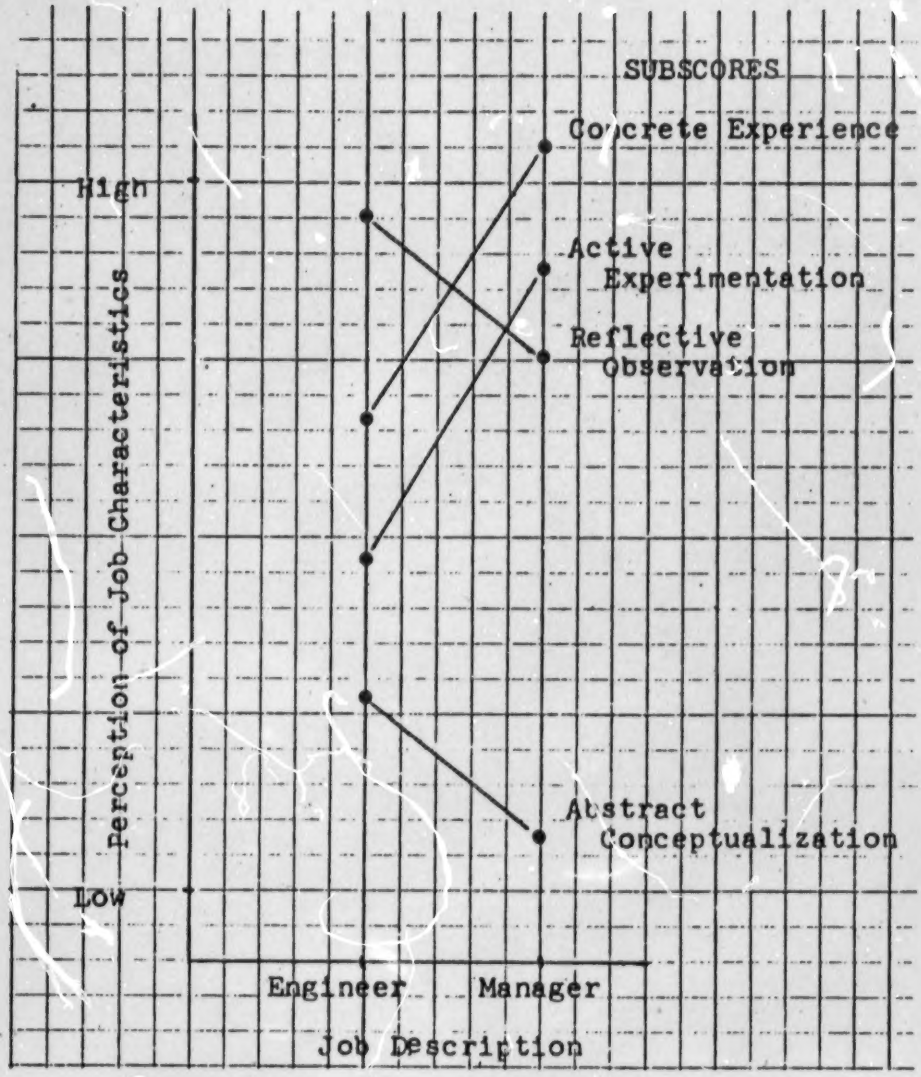

Figure 4. The interaction of job characteristics and job description subscores.

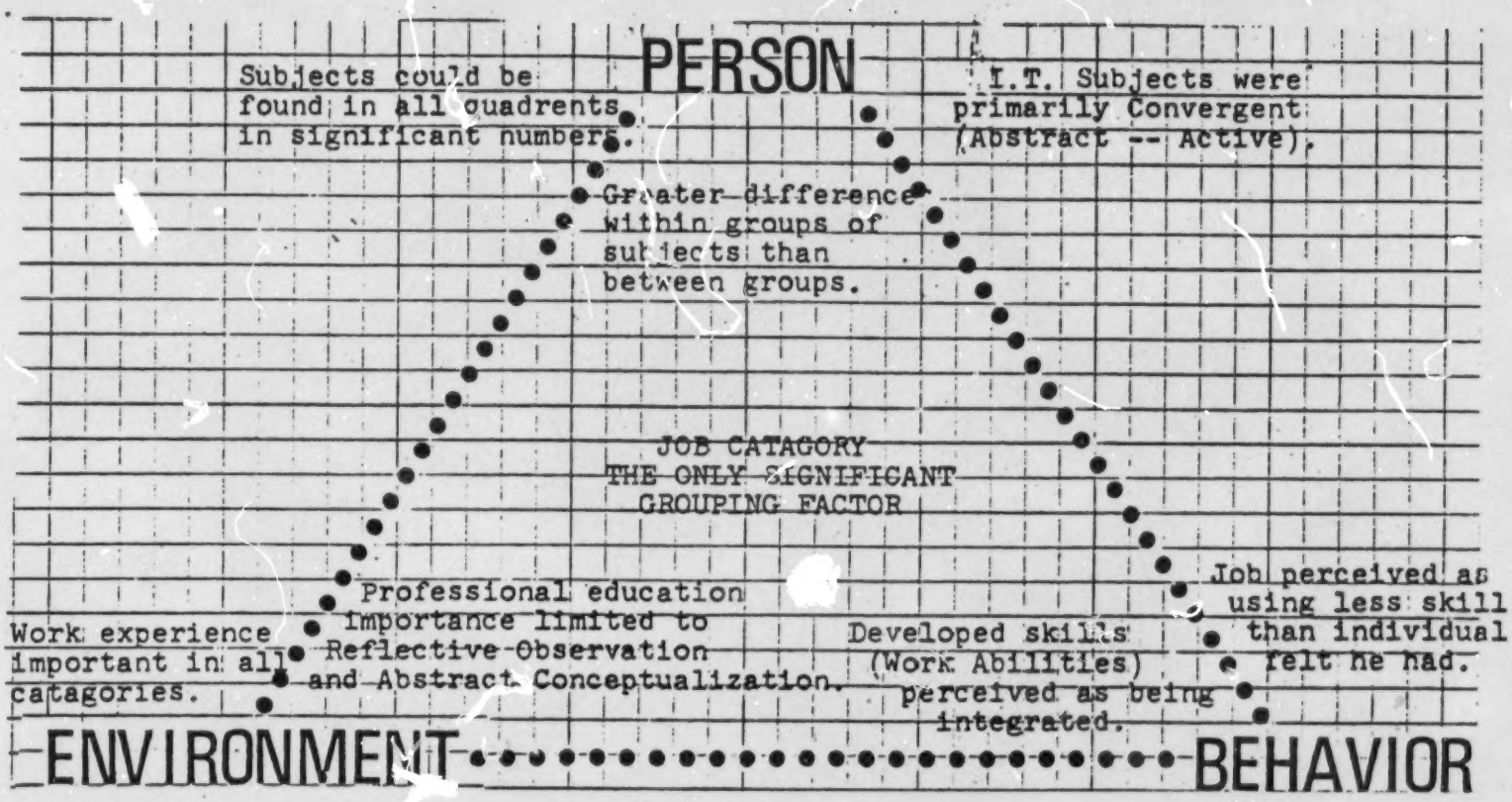
PERSON
Subjects could be found in all quadrents in significant numbers.
I.T. Subjects were primarily Convergent (Abstract -- Active).
Greater difference within groups of subjects than between groups.
JOB CATAGORY THE ONLY SIGNIFICANT GROUPING FACTOR
Job perceived as using less skill than individual felt he had.
Professional education Importance limited to Reflective-Observation and Abstract Conceptualization.
Work experience important in all catagories.
Developed skills (Work Abilities) perceived as being integrated.
ENVIRONMENT
BEHAVIOR

Figure 5. The association of lifelong learning and career patterns to the Bandura model.

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